Can honeybees pollinate *Grevillea*?

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ABSTRACT

The likely impact of the honeybee on a native pollination system was examined by studying the effectiveness of honeybees *(Apis mellifera)* as pollen vectors of *Grevillea* × *gaudichaudii*, near Bargo, New South Wales. Honeybees were the most frequent visitors to *Grevillea* inflorescences at the study site. Bees were found to be specific in their foraging, because only one pollen type was represented in the corbicula of each bee returning to a hive but the *Grevillea* was not present in these pollen loads. Bees were observed foraging for nectar on *Grevillea* plants in the study area, but had no *Grevillea* pollen on their bodies and failed to transfer pollen to stigmas of 500 flowers during two hours of observations over two days. It is concluded that bees harvested nectar from this plant species without effecting pollination, and would therefore make the plants less attractive to native pollinators without compensating for any consequent reduction in reproductive success.

INTRODUCTION

The honeybee, Apis mellifera L., has been a conspicuous component of the insect fauna in Australia for many decades (Doull 1973; Pyke and Balzer 1985). The species is now so widespread and abundant that even populations of native plants at some distance from human habitation may be visited by honeybees harvesting either pollen or nectar, and honeybees often outnumber native bees at flowers.

Studies in other parts of the world have drawn attention to the likely deleterious effects of the introduced honeybee on native plants and/or pollinators (e.g., Schaffer *et al.* 1979; Roubik 1980). There are two main categories of deleterious effects. Firstly, the social and aggressive honeybee may exclude populations of other animals, such as native bees, flies and wasps, by more efficient exploitation of the common resources of pollen and nectar (Pyke and Balzer 1985; Roubik 1978, 1980). Secondly, if honeybees are ineffective as pollinators, their exploitation of the rewards offered by flowers to attract effective, native pollinators (pollen and nectar) could lead to reduced reproductive success of the plants (e.g., Hamilton 1917; Pyke and Balzer 1985; Hopper 1987), either because native pollinators are no longer attracted to flowers with reduced nectar or because most of the pollen has been removed before they visit a flower. As a result of these possibilities, conservation groups and National Parks Services in Australia have expressed concerns about the effects of both feral colonies of *Apis mellifera* and also the placement of bee hives within or adjacent to Nature Reserves (D. Garrood, Jervis Bay Nature Reserve, pers. comm.; Blyth 1987).

Despite these concerns, there are very few published studies of the impact of honeybees on natural pollination systems. Our study examined the effectiveness of pollen transfer by honeybees to stigmas of *Grevillea* × *gaudichaudii* to answer the question of whether the honeybee could be considered a potential pollinator. This sprawling shrub is a natural hybrid between *G. acanthifolia* and *G. laurifolia* (Wrigley and Fagg 1979). The native animals most frequently observed visiting this plant species in the study area were Eastern Spinebills (*Acanthorhynchus tenuirostris*). The size of this bird in relation to the dimensions of the flowers, its position when probing flowers and its abundance in the area indicates that it was the most likely native pollinator.

METHODS

The study area was a eucalypt woodland in Wirrimbirra Sanctuary near Bargo, New South Wales. The understorey was dominated by species of *Acacia*. Species of *Acacia, Westringia, Callistemon, Eriostemon* and *Grevillea* were in flower in the study site during the study period (20 September to 18 October 1986).

The specificity of bees foraging in the study area was estimated by collecting bees returning to five hives in the area and sampling and identifying pollen contained in the corbicula (pollen baskets on hind legs). Bees were killed and pollen removed from the corbicula

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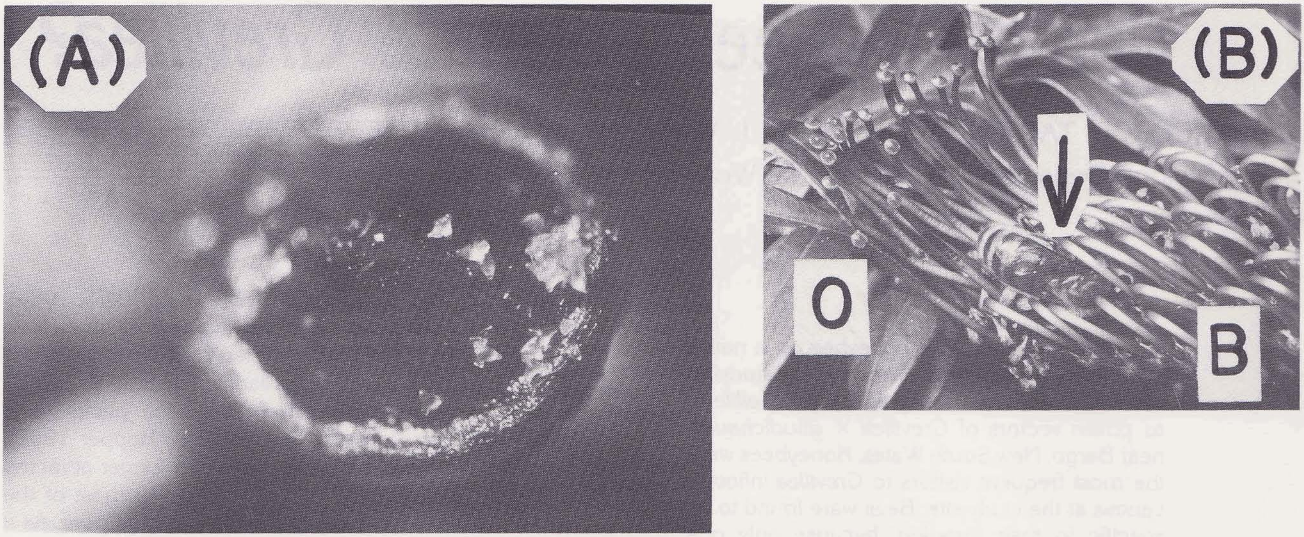

FIG. 1: Structure of the flowers and inflorescences of Grevillea × gaudichaudii. *(A) Tip of the style, with the plate-like pollen presenter (about 3 mm long) surrounding the small, dimple-like stigma. Some of the flower's own pollen grains are evident around the margin of the pollen presenter. (B) Arrangement of flowers on an inflorescence (about 7 cm long), in which "O" indicates open flowers, "B" indicates flowers still in bud, with style tips still inserted in the corolla tube. The arrow indicates a honeybee foraging, in typical fashion, at the boundary between newly opened and unopened flowers.*

by dabbing them in a few drops of 70% ethanol on a glass slide. Photographs taken of the resulting pollen smears under the light microscope allowed pollen types to be distinguished, by comparison with standards taken from plant species, including *Grevillea* in the area.

The effectiveness of the bees as pollinators of the *Grevillea* was assessed in two ways. Firstly, ten bees (two caught at each of five hives) were examined microscopically to detect the presence of *Grevillea* pollen on the body, rather than in the corbicula. It is likely to be only this pollen on the body that is available for pollination, because pollen grains in the corbicula are "glued" together with a waxy substance and would not be dislodged on to stigmas of flowers visited. Five bees captured within the study area, during observations on bee visits to *Grevillea* inflorescences, were also examined in this way. Secondly, pollen transfer to stigmas was measured. This procedure involved washing open flowers on 15 inflorescences (500 flowers total) with water to remove all traces of pollen from the stigmas and the surrounding pollen presenters. The newly opened flowers (about five per inflorescence), which contained a full load of pollen on the pollen presenter, were left untouched to provide a source of pollen for transfer to other flowers on the same inflorescence or to other inflorescences.

For one hour on each of two days (10-11 October 1986), bee visits to these 15 inflorescences were counted. Other potential pollinators in the area (e.g., other large insects, honeyeaters) were scared away from the test inflorescences while under observation. When not under observation, the test inflorescences were bagged with fine mesh to exclude all potential pollinators, including the bees. After the two hours of exposure to bee visits, each individual flower was sampled for pollen by pressing a strip of sticky tape against the pollen presenter and sticking the tape to a glass slide for later microscopic examination.

Structure of the *Grevillea* flower

Interpretation of the following results requires an understanding of the structure and functioning of the flowers and inflorescences of *Grevillea × gaudichaudii.* The individual flower is typical of other members of the family Proteaceae in that the pollen is "presented" to pollinators on a specialized structure surrounding the stigma, known as the pollen presenter (Carolin 1961). In this species, the stigma is apparent as a small, raised dimple in the centre of the pollen presenter (Fig. 1(A)).

Flowers occur in groups of about 50 in a toothbrush-like inflorescence (Fig. 1(B)), opening first at the proximal end and then sequentially to the distal end. Flowers still in bud have sharply curved styles, with pollen presenters contained within the perianth, adjacent to the anthers which adhere to the inside of the perianth segments. After opening, flowers have their own pollen removed by visitors such as honeyeaters, exposing the

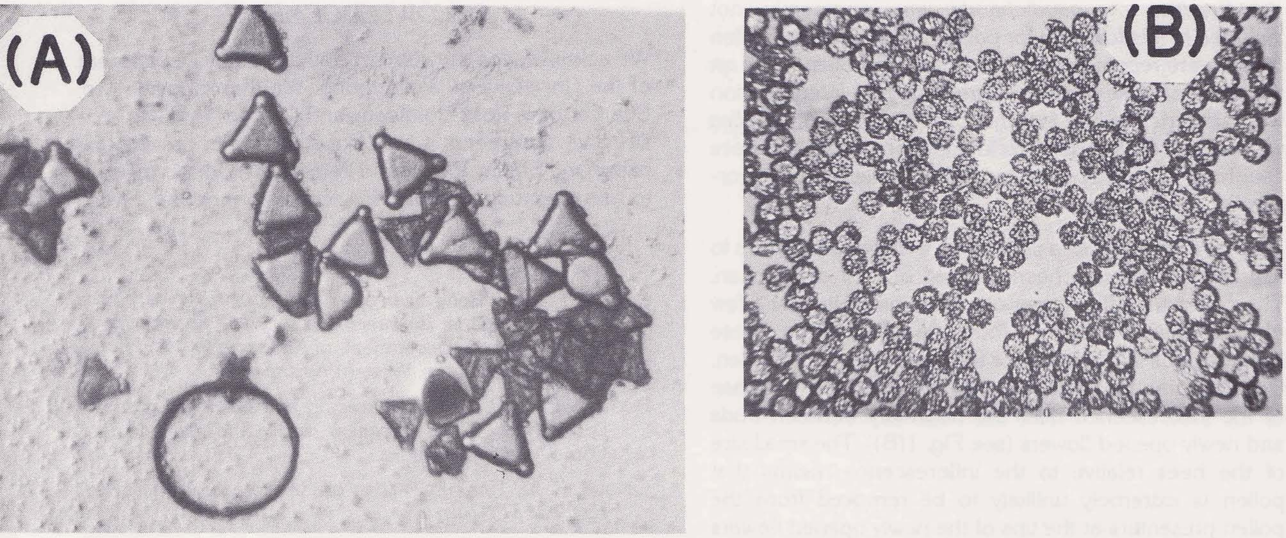

FIG. 2: (A) Pollen standard from Grevillea × gaudichaudii *flower, showing triangular pollen grains (65 microns across), with shape typical of* Grevillea *species. (B) Typical pollen load, at same magnification, from corbicula of a bee collected returning to hive near study site.*

stigma so that the flower is then able to be fertilized by pollen deposited by subsequent pollinators. The detail of the timing of flower development has not been examined closely in most native Proteaceae. Some detail for *Grevillea* species is given by Lamont (1982) and Harriss (1987). Dissection of several inflorescences revealed that both newly opened flowers and also the adjacent flowers still in bud were actively secreting nectar.

RESULTS

Specificity of bees within the study area

All bees caught on their return to hives in the study area had substantial pollen loads in their corbicula. All ten bees carried pollen loads of only a single pollen type indicating a high degree of specificity while foraging for pollen. No *Grevillea* pollen grains were recorded in any corbicula samples, all being from species of other genera in the study area (Fig. 2).

Pollen loads on bee bodies

Not one of the bees caught on return to the hives had pollen present on the body, despite having large pollen loads in the corbicula. Only one of the five bees caught foraging in the study area carried pollen on the body; only eight grains were observed and none was from *Grevillea*. These bees were apparently specializing on nectar rather than pollen, because all lacked pollen loads in their corbicula. Observations of bees feeding at *Grevillea* flowers revealed that they typically burrowed into the base of the inflorescence near the boundary between buds and newly opened flowers (see Fig. 1(B)). The open flowers at the boundary and the buds that would be next to open were observed to be secreting nectar.

Pollen transfer between *Grevillea* flowers

Over two hours of observations on 15 test inflorescences with flowers cleaned of pollen, 396 bee visits were observed. Inflorescences received an average of 26.4 bee visits each over the two hours of observations. All of the 15 inflorescences examined had acquired some new *Grevillea* pollen during the 2 hours but pollen was found on the pollen presenters of only 32 of the possible 500 flowers, with a mean of 1.4 pollen grains per flower for these 32. The most important observation was that in no case was pollen transferred to the stigma of a test flower.

DISCUSSION

Although individual honeybees caught while returning to hives had only one, or at most two, pollen types present in corbicula (see also Bell 1987), different bees were specializing on different plant species. A second pollen type might occur in corbicula if the flower visited already contained a small amount of pollen from a different species, deposited there by another pollinator.

Grevillea × *gaudichaudii* was apparently not included in this foraging for pollen, as no *Grevillea* pollen grains were represented in the corbicula pollen loads on the small sample of bees examined. This interpretation was supported by the fact that bees visiting the *Grevillea* were observed foraging exclusively for nectar and bees caught in the study area carried no pollen in their corbicula.

Very little *Grevillea* pollen was transferred by bees to test flowers that had been cleaned of their own pollen. The pollen that did appear on pollen presenters of a few of these flowers was never found near the stigma. There is an obvious explanation for this poor transfer of pollen. Bees foraging for nectar typically burrowed into the base of the inflorescence near the boundary between buds and newly opened flowers (see Fig. 1(B)). The small size of the bees relative to the inflorescence means that pollen is extremely unlikely to be removed from the pollen presenters at the tips of the newly opened flowers during feeding. Even in the unlikely event of this occurring, pollen would rarely be transferred to those flowers available for pollination, some rows away from the bud-flower boundary (Fig. 1(B)).

We conclude that the introduced honeybee is a very ineffective pollinator of *Grevillea* × *gaudichaudii* because it harvests nectar from inflorescences without any measurable transport of pollen. We suggest that this situation is likely to be widespread, applying not only to other species of *Grevillea* but also to many native plant species which have evolved to specialize on vertebrates as pollinators. Such species are likely to have anthers and stigmas so far from the nectaries that honeybees could not effect pollination while foraging for nectar. We consider that honeybees should be considered only as "visitors" to flowers, not "pollinators", until pollen transfer and fertilization is established.

Harvesting of nectar by honeybees is likely to have detrimental effects on the natural pollination of the plant species. We have observed that a high level of bee activity appeared to deter honeyeaters from visiting an inflorescence (see also Roubik 1982). The depletion of standing crops of nectar is likely to make flowers less attractive and they may therefore receive fewer visits from effective pollinators (Roubik 1982). Paton (unpublished) found that addition of bee hives to a *Banksia* population in South Australia caused changes in the activities of the principal, native visitors to flowers, namely the honeyeaters. Both Pyke and Balzer (1985) and Bell (1987) quoted reports of similar findings.

- See centre spread for colour photographs for this paper.

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